BRITISH MUSEUM (NATURAL HISTORY).

SPECIAL GUIDES: No. 1.

GUIDE TO AN EXHIBITION OF OLD NATURAL HISTORY BOOKS, ILLUSTRATING THE ORIGIN AND PROGRESS OF THE STUDY OF NATURAL HISTORY UP TO THE TIME OF LINNÆUS.

LONDON:
PRINTED BY ORDER OF THE TRUSTEES
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1905.
[PRICE 3D.]

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PREFACE.

This Guide, which is intended to be the first of a special series, has been drawn up to accompany an exhibit of Old Natural History Books which illustrate the origin and progress of the study of Natural History up to the time of Linnæus.

It makes no pretence of giving a complete history of the contributions of all writers, but is practically limited to such works as have contributed to the advancement of the science.

It has been compiled chiefly by the Assistant in charge of the General Library, Mr. B. B. Woodward, with assistance in technical matters from officers in the several departments, and from members of the staff at the British Museum, Bloomsbury.

E. RAY LANKESTER,
Director.

British Museum
(Natural History),
March, 1905.

ON THE ORIGIN AND PROGRESS OF THE STUDY OF NATURAL HISTORY UP TO THE TIME OF LINNÆUS, AS ILLUSTRATED BY A SERIES OF OLD WORKS ON NATURAL HISTORY IN THE MUSEUM.

OF THE earliest beginnings of the proper study of Natural History no information is available, or to be expected; it began with the dawn of civilisation, and doubtless had its origin, so far as animals and plants were concerned, in the primitive observations of the Hunter and of the Medicine-man, or Priest-Physician, while the search for stone, and subsequently for metals, with which to fashion weapons and tools, served to draw attention to the nature and structure of the earth.

That the Hunters of the Stone Age were not unobservant of the Quadrupeds they pursued is evinced by the carvings and the incised outline representations on bone, as well as the really remarkable pictures, drawn in manganese and red ochre, on the chalk walls of some caves in the South of France (Dordogne). Nos. 1 & 2. No. 3.

Plants they do not appear to have delineated, although many of the animals are depicted in the act of browsing.

Both Plants and Animals, on the other hand, appear on Egyptian and Assyrian monuments, though they figure as adjuncts to the scenes depicted, and not as the central objects of the design.

At the same time the love of the Egyptians for Animals of all sorts, especially for those sacred to special deities, is well known. These, such as the Cat, Dog, Hawk, Ibis, &c., and

in some districts the Monkey and Crocodile, were carefully embalmed at death.

The ancient Egyptians, however, made no systematic study of Natural History; nor did the early Greek philosophers.

Some scattered observations are met with among the writings of the latter, while to PYTHAGORAS [B.C. 569–470] have been attributed ideas concerning the changes in relative level between sea and land that may not improbably be those of later observers. HERODOTUS [B.C. 484–406] certainly mentions the occurrence of shells, presumably marine, on the hills of the Nile Valley, and deduces from that and other facts the former extension of the sea over that area.

HIPPOCRATES [B.C. 460–361], the priest-physician, and "Father of Medicine," mentions the uses of some 240 plants.

THE first person, however, to whom belongs the credit of instituting a genuine study of Natural History was ARISTOTLE [B.C. 384–322], and he has therefore been justly called the "Father of Natural History."

His writings on Animals, of which he appears to have known some 500 species, would seem to contain a certain admixture of astronomical symbolism; or else portions belonging to his astronomical writings were by an error of his first transcribers incorporated with those on animals, and this, considering the conditions under which his MSS. had been preserved, would not be remarkable.

Although Aristotle proposed no definite classification of Animals, it is deducible from his writings that he divided them into Enæma, or those having (red) blood, and Anæma, or those without, and subdivided the former, or Vertebrata, into:—Vivipara, Birds, the other Ovipara, and Fish; while the latter, or Invertebrata, were subdivided into:—Malakia, Malakostraka, Entoma, and Ostrakoderma. The insects (Entoma) he yet further subdivided, and three of his groups, Coleoptera, Psychæ [= Lepidoptera] and Diptera, hold good at the present day. The only formal terms of classification employed by him are eidos, or species, and genos, or genus, the latter being far more vaguely used than at the present day.

In Botany and Mineralogy little was done by Aristotle, and

nothing in Geology as now understood, although it is interesting to note in passing that he maintained the earth to be a spherical body, while he was acquainted with the occurrence of fossils in the rocks, and discussed the changes on the earth's surface necessary to account for them.

It was Aristotle's favourite pupil THEOPHRASTUS [B.C. 371–286], to whom he bequeathed his MSS., who took up the subjects of Botany and Mineralogy. Theophrastus described some 500 kinds of Plants used in Medicine, which he roughly grouped according to size and texture, or use. He theorized on the existence of sexes in plants, but made no observations himself. Minerals were at that time classified into "Metals" and "Stones," and only his treatise on Stones has survived: it is chiefly interesting as showing what characters were made use of at that time for the discrimination of Minerals and the description of the species, as well as a record of the places of their occurrence.

After many vicissitudes, which included burial in a catacomb, the remains of the combined MSS. of Aristotle and Theophrastus passed into the hands of Apellicon of Teos [–B.C. 85], who attempted their restoration and had them copied. The transcripts were afterwards seized by Sylla and conveyed to Rome, where they were subsequently edited and given to the world by Andronicus of Rhodes; but their real publication dates from 1495, when they were first printed in the original Greek by the celebrated Venetian printer, Aldus Manutius. **No. 4.** A Latin translation by T. Gaza of Theophrastus' *De historia et causis Plantarum*, had, however, been printed at Treviso in 1483.

GEOLOGY, or more strictly speaking, physical geography, first received serious attention at the hands of STRABO [B.C. 63 ? – A.D. 24], who originated the theory of the alterations of the level of the land in relation to the sea, in contradistinction to the former belief in the changes of the sea-level. His *Geographicon*, which was written in the early years of the Christian Era, was printed, from the Latin translation, at Venice in 1472 by Vindelinus de Spira, and appeared in the original Greek in 1516 from the press of Aldus Manutius.

No. 5. THE oldest popular natural history book, and almost encyclopædia, was the *Historia Naturalis*, also termed the *Historia Mundi*, of PLINY THE ELDER [A.D. 23–79]. This voluminous treatise in thirty-seven books has been preserved, and presents an epitome of the state of Roman knowledge on the subject. The number of known Plants had by this time increased to about one thousand, and the belief in the existence of sexes in Plants had become established; while in the Minerals the "Earths" had been made into a class apart from "Metals" and "Stones." It was probably the earliest work on Natural History to be printed, the editio princeps emanating from J. de Spira's press at Venice in 1469.

THE next most important work was the celebrated *Materia Medica* of DIOSCORIDES [A.D. 40 ? –]. This was a standard book for over a century and was the basis for most of the early Herbals.

It was first printed at Medemblik, Holland, in 1478, from a Latin translation, made by Hermolaus Barbarus. The Greek editio princeps, from the press of Aldus Manutius, at Venice, appeared in 1499. The work became the subject of much discussion, and of many Commentaries by early Botanists of the Renaissance, especially P. A. MATTIOLI [1500–1577] and his contemporaries, who, ignorant of the differences between the floras of east and west Europe, were led into endless difficulties in their attempts to identify their plants from the imperfect definitions of Dioscorides.

THE three Greek writers, Hippocrates, Theophrastus, and Dioscorides, are the authorities for all the Greek names of Plants up to the Christian Era.

WITH the epoch of Pliny and Dioscorides the classical period of Natural History may be said to have been brought to a close: the works of the older writers became less studied in Europe, and commonplace-books like those of Ælian of Praeneste, a compiler who lived in the third century, were much used. In these, scraps of folk-lore, travellers' tales and fragments of misapprehended science were set forth in the elegant style then affected. An edition of Ælian's collected

works was issued by Gesner in 1556, and a good edition of his *De Natura Animalium* was brought out in 1774 under the editorship of Abraham Gronovius. No. 6.

The early Christian writers, none too conversant with Natural History, utilized these works, without question as to their reliability, in their allegorical interpretations of Biblical texts. Hence arose a series of collections, in many languages, of some fifty Christian allegories, much read and quoted in the Middle Ages, known by the common title of the *Physiologus*, or, since most of its imagery was borrowed from the animal world, the *Bestiary*.

On such productions as these were based the Natural History writings of the Middle Ages—"Dark" indeed as regards progress in scientific learning.

WHILE the works of the classical writers were neglected in Europe, their study was taken up by the Arabian Philosophers, who made some advance, more especially in the knowledge of medicine and chemistry, and their contributions were largely utilized in works issued in the centuries immediately succeeding.

Among these Arabian philosophers three call for special mention.

Ḥusain Ibn 'Abd Allāh, called Ibn Sīnā, or Avicenna [980–1037], whose *Canon* (first printed about 1470) was the principal authority in medical matters for centuries, wrote on the formation and classification of Minerals. He merged the "Stones" and "Earths" into a single class, but, on the other hand, created two additional classes, "Salts" and "Sulphurs," the latter including various combustible substances (*e.g.*, bitumen) which, at that time, were held to contain sulphur.

Serapion, or Yūḥannā Ibn Sarapion [fl. 8th or 9th century] was author of the oldest known treatise on medicine in Arabic. A Latin translation by Symon a Cordo, *Liber Serapionis aggregatus in medicinis Simplicibus*, printed at Parma, in 1473, by Antoninus Zarotus, is one of the oldest known Herbals. No. 14.

Averroes, or Muḥammad Ibn Aḥmad [1149–1198], chiefly celebrated for his Commentaries on Aristotle, also wrote

a medical work (largely drawn upon by later compilers of Herbals), of which a Latin translation first appeared in 1490.

AMONG mediæval European writers the following deserve notice :—ALBERTUS (Albert von Bollstädt), called ALBERTUS MAGNUS [1193–1280], a Dominican, and sometime Bishop of Ratisbon, who, among his numerous writings, included
No. 9. Commentaries on Aristotle and treatises :—*De Animalibus*, first printed in 1479, *De Mineralibus*, printed 1495, and *Tabula*
No. 8. *tractatuum parvorum naturalium* (in which were comprised his *De Vegetabilibus et Plantis*) printed in 1517.

VINCENTIUS BELOVACENSIS, or VINCENT OF BEAUVAIS [c. 1190–c. 1264], another learned Dominican, who resided at the court of Louis IX. of France, compiled at the instance of
No. 7. that king a *Bibliotheca Mundi*, which is not only one of the earliest of encyclopædias, but the greatest of the Middle Ages. The first part, entitled *Speculum Naturale*, written about 1250, contains thirty-three books. It was first printed at Strasburg about 1473.

BARTHOLOMÆUS (Bartholomew de Glanville), called BARTHOLOMÆUS ANGLICUS [fl. 1230–1250], a Minorite Friar,
No. 13. compiled an encyclopædia entitled : *De Proprietatibus Rerum*, which as a manuscript was known in Italy in 1283 and in England in 1296. It was first printed at Basle about 1470, and was the source of common information on Natural History during the Middle Ages.

THESE authors were followed after a long interval by :—

LEONARDO DA VINCI [1452–1519], who was not only a great painter, but had also vast knowledge, among other subjects, of Anatomy, Botany, and Geology. He vigorously maintained that the contents of the rocks were real shells, and supported the belief in the changes of sea and land which this view implied. His writings on these subjects were not printed from the original manuscripts till 1881 and 1883.

GIROLAMO FRACASTORO [1483–1553] declared his opinion that fossil shells had all belonged to animals which had lived and multiplied in the places where their exuviæ are now found, but he was not listened to.

AMONG other manuscript books in circulation at the time of the invention of printing were some household recipe-books for medicines, or Herbals, compiled by unknown persons from the works of various old medical writers and other sources.

Among the earliest of these Herbals were the Herbarius of Apuleius, printed at Rome about 1480, or later; and the *Herbarius*, also known as the *Aggregator practicus de Simplicibus*, which was issued in 1484 by the Mainz press. Both contain crude woodcuts of the plants, and the latter went through several editions. No. 10. No. 15.

Another Herbal of note was the *Ortus Sanitatis* by J. von Cube, issued about 1475 at Mainz, in German. Latin editions appeared about 1490 and later, but are undated and mostly without any indication of the place of imprint. Nos. 11 & 12.

Many of these Herbals contained accounts of the Animals as well as of the Plants used in medicine, and were illustrated by quaint wood-cuts; some of the subjects depicted are recognizable, while some refer to purely legendary creatures, and other figures are creations of the artist, who had only the names and vague descriptions to guide him, and who consequently produced some truly remarkable illustrations.

The earliest English Herbal appears to have been *The Grete Herbal*, translated from the French, and printed at "London in Southwark" by Peter Treveris in 1526; while among the latest were *The Garden of Health*, by Wm. Langham, London, 1633; *The English Physician*, by N. Culpeper, London, 1652; and the *Botanologia* of Wm. Salmon, 2 vols., London, 1710–11. Culpeper's was a most popular book, and was reissued in various forms down to quite recent times. No. 16. No. 19.

WITH the close of the fifteenth century the Credulous or Legendary period of Natural History study gave place to an era of renewed investigation at first hand; and this renaissance was furthered by the discovery of new Animals and Plants in distant countries as one of the first results of the period of great geographical discovery then initiated.

FROM the confusion engendered by the Herbals, with their more or less mythical Plants and Animals, the study of Botany was the first to be rescued and restored to its proper place as a

science by Otto Brunfels [1488–1534], whose well illustrated
No. 17. *Herbarium* was printed at Strasburg in 1530–1536.

Among his botanical contemporaries and successors were :—

Euricius Cordus [*i.e.*, Heinrich Eberwein, 1486–1535], who wrote a *Botanologicon*, published at Cologne in 1534 ; and his son Valerius [1515–1544], who annotated Dioscorides, and also wrote on Metals.

Johannes Ruellius [c. 1474 – 1537] whose *De natura Stirpium* appeared at Paris in 1536.

Hieronymus Bock [1498–1554], better known under the Latin version of his name as Tragus, who was author of a celebrated *Kreütter Buch* first issued in 1539.

No. 21. Leonhard Fuchs [1501–1566], whose *Historia Stirpium* was printed at Basle in 1542, and is specially worthy of note on account of the excellence of its illustrations.

In England there lived at this time "The Father of English Botany," William Turner [c. 1515–1568], Dean of Wells,
No. 18. whose *Libellus de Re Herbaria novus*, printed at London in 1538, is now a very scarce work. His *Names of Herbes* followed in 1548, and was very largely an extension in English of the *Libellus*. To this in 1551 succeeded the first part of his *New*
No. 20. *Herbal*, a beautifully printed work with good illustrations.

MINERALOGY and Metallurgy were next brought into more scientific order by Georgius Agricola, whose real name was Bauer [1494–1555], the "Father of Metallurgy." Agricola was the first to make proper use of the external characters in the distinction and description of Minerals. He introduced the term *Succi Concreti* for those minerals which he regarded as the results of coagulation, and which he was unable to class with Earths, Stones or Metals. His *De ortu & causis subterraneorum* and *De natura Fossilium* appeared together in 1546 ; these were
No. 25. followed in 1556 by his *De Re Metallica.*

THE restoration of Zoology to scientific rank was the work of Edward Wotton [1492–1555], who was the first English physician to make a systematic study of Natural History. In
No. 26. his *De differentiis Animalium*, printed at Paris in 1552, he discarded the legendary animals and reverted to the sounder methods of Aristotle.

His work was quoted with approval by CONRAD GESNER [1516–1565], the celebrated Swiss physician and naturalist, who wrote a series of natural history works that appeared at Zurich between 1551 and 1556. Gesner's Zoology was mainly a compilation; but in Botany he introduced the first clear conception of genera, and proposed, in letters published after his death, the earliest methodical system of classification based on the structure of the flower and the seed. **No. 27.**

Gesner appears to have led the way in forming a proper Zoological Cabinet, and in laying out a Botanic garden.

WITH the advance of geographical exploration, works on the Natural History of regions beyond Europe and the Near East began to appear early in the sixteenth century.

Of these Northern Africa was naturally the first to receive attention, and LEO AFRICANUS, whose real name was ḤASAN IBN MUḤAMMAD, but who afterwards assumed the name of GIOVANNI LEONE [– c.1526], wrote in Arabic a work subsequently published in Latin at Antwerp in 1556, as *De totius Africæ descriptione libri* 9.

The West Indies and North America were the next to receive attention. GONZALO FERNANDEZ DE OVIEDO Y VALDES [c.1478 – c.1560] wrote an *Historia general y natural de las Indias Occidentales*, of which the first twenty books were printed in 1535, though the whole fifty were not completed till 1783; while NICOLAS MONARDES [1493–1588], a Spanish doctor of Seville, described in 1569 the Plants and Animals used for medicine in the West Indies. **No. 23.**

The Near East as a whole was next treated of by PIERRE BELON [1517–1564], a French naturalist, in his *Observations de pleusieurs singularitez* published at Paris in 1553. **No. 22.**

India and the Far East, a few years later, were the subject of treatises, principally on the drugs, by GARCIAS DE ORTA, who, in 1563, published a *Coloquias dos Simples, e Drogas he cousas mediçinais da India*, etc., of which a Latin version was issued at Antwerp four years later; and by CHRISTÓBAL ACOSTA [–1580], whose *Tractado de las Drogas . . . de las Indias Orientales, con suas Plantas*, etc., appeared in 1578.

Brazil meantime was visited, when the French Protestants

were there, by ANDRÉ THEVET [1502–1590], who in 1558 described *Les Singularitez de la France antarctique, autrement nommée Amérique.*

THE study of Fishes was at this time greatly advanced by three writers who are held to be the founders of modern Ichthyology :—PIERRE BÉLON [1517–1564], *De Aquatilibus*, Parisiis, 1553; GUILLAUME RONDELET [1507–1566], *Libri de Piscibus Marinis*, Lugduni, 1554–55 ; and IPPOLITO SALVIANI [1514–1572], *Aquatilium Animalium Historiæ liber primus*, Roma, 1554 [*i.e.*, 1557]. All three themselves saw and examined the Fishes they described, and gave faithful representations of them, but were more exercised to make out the names which the different kinds bore in the ancient writings than to describe them lucidly themselves.

FOR some time subsequently the history of the progress of Natural History was mainly that of Botany, and among the more distinguished writers were :—

REMBERT DODOENS [1517–1585], the well-known botanist and professor of physic at Leyden, who was author among many other works of a *Cruijde Boeck*, which was issued at Antwerp in 1554, but subsequently, being much sought after, went through many editions in several languages, including English. It was also issued in an abbreviated form by W. Ram, and as *Ram's Little Dodeon* (London, 1606) enjoyed considerable notoriety.

CHARLES DE LÉCLUSE [1526–1609], who travelled extensively in Western Europe making collections, wrote several books on the botany of the districts he visited, besides editing editions of the works of Dodoens, Orta and Monardes. He introduced exactitude, neatness and method into botanical descriptions, as well as the custom of giving references to the pages of works cited. In his *Rariorum Plantarum historia*, Antwerp, 1601, are given the earliest figures, from drawings made by him in 1589, of the Potato, which plant was growing in Italy in 1586.

No. 28.

MATTHIAS DE L'OBEL [1538–1616], at one time botanist to James I., had a physic garden at Hackney. He made many excursions and added a good many plants to the British Flora.

In association with PIERRE PENA [fl. 1535–1605], he published, in London in 1570–71, a *Stirpium adversaria nova*, in which a rough classification of Plants into classes or groups is attempted. In 1576 his *Plantarum, seu Stirpium Historia* appeared at Antwerp; this was very fully illustrated, the printer, Plantin, having possessed himself of the blocks to works by Mattioli and Dodoens as well as to those edited by Lécluse. These figures were also issued apart from the text with an index in seven languages, and in this form made a popular work of reference for years, that was quoted by Linnæus. No. 30.

JACQUES D'ALECHAMPS [1513–1588], a French physician and botanist, whose *Historia Plantarum*, published at Leyden in 1586–87, gave account of over 1,000 species.

JACOB THEODOR, of Berg-Zabern, in Alsace, wrote, after the manner of his time, under his Latin designation as JACOBUS THEODORUS TABERNÆMONTANUS [1520–1590], and became quoted under the last name.* He wrote a *Neuw Kreuterbuch*, published at Frankfort in 1588–91, and noted for its illustrations. These figures were also issued as a separate work, entitled *Eicones Plantarum*, in 1590, and subsequently, 1597, used for Gerard's *Herbal.* No. 29.

A man of a very different stamp to the preceding was ANDREAS CÆSALPINUS [1519–1603], the celebrated Italian naturalist, who, besides being an eminent student of Aristotle (whose philosophy he explained and defended), was an original worker of note, with attainments that were considerably in advance of his times. He almost anticipated Harvey in the discovery of the circulation of the blood. In his *De Plantis*, published in Florence in 1583, he put in practice the method proposed by Gesner of classification by the fructification, and the care and thoroughness of this work elicited high praise from Linnæus, who styled him "primus verus systematicus."

He also contributed to the study of mineralogy, instituting a class for the minerals which are soluble in oil, corresponding to the class Salts, which included all soluble in water. In the same work (*De Metallicis*, Rome, 1596), he also maintained that fossil shells had been left on the land by the retiring

* There is, however, absolutely no justification for a modern citation of him as "Tabernaemontan."

sea, and had concreted into stone during the consolidation of the soil.

Another Italian naturalist of note, FABIO COLONNA [1567–
No. 33. 1650], published in 1592 a *Phytobasanos* remarkable for the beauty of its illustrations. He extended Cæsalpinus' method of classification to the formation of genera, but did not draw up a system. In Geology he was the first to point out in his *Osservazioni sugli Animali aquatili e terrestri* that some fossils belonged to marine and others to terrestrial testacea.

JOHN GERARD [1545–1612], a celebrated English botanist, had a garden in Holborn, of which he published a Catalogue (the first to be made of any garden) in 1596 and again in 1599. L'Obel's copy of the second edition is in this Museum, and contains his manuscript notes and denial of the attestation printed at the end stating that he had seen the plants growing in Gerard's garden that are enumerated in the work. Gerard's
No. 31. great work, however, was the *Herbal*, published in 1597, compiled chiefly from Dodoens after the method of L'Obel and illustrated by cuts mostly taken from a work of Theodorus Tabernæmontanus. He did much to advance the knowledge of Plants, while to him is due the discovery of many species then new to England.

THE next serious attempt, after that of Gesner, to compile a universal natural history, or encyclopædia, was made by ULISSE ALDROVANDI [1522–1607], the Italian naturalist, who spent his patrimony over the compilation and production of his series of well-known volumes, which were issued at Bologna between 1599 and 1668. He has fortunately
No. 34. preserved to us the accounts of Monsters, both mythical and actual, accepted up to his time.

THE study of Mineralogy was not greatly advanced at this period, and the only work of any note is that by ANSELM BOETHIUS DE BOODT [1550–1634], physician to the emperor
No. 32. Rudolf II., who published in 1609 a *Gemmarum et Lapidum historia*, which was long a work of practical value, although it was chiefly devoted to the minerals used as gems. In it he figures a lapidary's wheel which is practically identical with a kind in use at the present day.

WITH the exception of the two last-named writers, the botanists continued the leaders of natural history study until far into the middle of the seventeenth century, the principal workers of note being :—

JEAN BAUHIN [1541–1613], a French physician and botanist, who wrote an *Historia Plantarum universalis*, which was issued after his death, under the care of Cherler and Chabræus, in 1650–1651. Though the classification was antiquated, the accuracy and clearness of the text caused Ray and others to attach great importance to this work.

CASPAR BAUHIN [1560–1624], brother to Jean, besides editing the works of Mattioli and Theodorus Tabernæmontanus, contemplated an exhaustive treatise on all known Plants.

The first and only published part of Vol. i. of his *Theatrum Botanicum* appeared posthumously in 1658 ; but his preliminary work, the *Pinax Theatri Botanici*, issued in 1623, that enumerated about 6,000 plants, became the universal text-book on Botany for nearly a century : it is quoted by Linnaeus in the latter's *Species Plantarum*. The distinction between genus and species is fully carried out in this work, and the nomenclature is very largely binomial.

THOMAS JOHNSON [–1644], an English botanist and physician, and afterwards colonel in the Royalist Army, was the author of the first local catalogues of Plants published in England. One of these referred to a part of Kent, and another to Hampstead Heath : they were issued in 1629 and 1632 respectively. He likewise brought out an improved edition of Gerard's "Herbal."

JOHN PARKINSON [1567–1650], Apothecary to James I. and Botanist to Charles I., is renowned for his book with the punning title *Paradisi in Sole Paradisus terrestris*, published in 1629 and quite lately reprinted. It is valuable as affording an exact view of the extent of floriculture at that period. His principal work, the *Theatrum Botanicum*, appeared in 1640, and contained descriptions of some 3,800 plants.

WILLIAM HOW [1620–1656] wrote the first British Flora. It appeared anonymously in 1650, under the title of *Phytologia Britannica*, and contains the names of 1,220 plants. No. 35.

WITH the foundation, during the middle of the seventeenth century, of effective scientific societies, the study of Natural History may be said to have entered upon a fourth period of its development—the period of co-operation.

The regular assembling of both collectors and practical observers with the object of communicating the results of observations made, and discussing subjects of common interest, had great influence in encouraging and promoting all scientific pursuits.

As early as 1560 an *Accademia Secretorum Naturæ*, also known as *De Secretis*, had been founded at Naples, but coming into collision with the Church, was dissolved by the Pope.

In 1603 the *Accademia de' Lincei* was founded at Rome by Cesi, but flickered out at his death in 1630.

No publications of these bodies survive.

In 1652 a number of German naturalists founded the *Academia Cæsarea Leopoldino-Carolina Naturæ Curiosorum*:
No. 38. this society, however did not publish till 1670, whereas the *Royal Society of London*, which was founded in 1662 (having existed as an informal body from 1645) began to issue its
No. 37. *Philosophical Transactions* in 1665.

The French *Académie des Sciences* was founded in 1666 (its members having begun as a private society in 1630), but only began to print in 1702.

In Italy the *Accademia del Cimento*, founded at Florence in
No. 39. 1657, issued its earliest *Saggi di Naturali Esperienze* in 1667; whilst the *Lincei*, revived for the third time in 1795 as the *Accademia Pontificia de' Nuovi Lincei*, did not venture on publication till 1851.

ALTHOUGH the study of Anatomy, as such, does not enter into the present history, certain important resultant Biological Discoveries of this period must be referred to, viz.:—

Firstly the discovery by WILLIAM HARVEY [1578–1657], of the Circulation of the Blood,* and his detection of the principle

* The circulation of the blood between the heart and lungs, and through the lungs, was known in 1553, and alluded to by the Spanish physician and martyr, *Miguel Serveto* [1511–1553], in his *De Restitutione Christianismi*.

"Ovum esse primordium commune omnibus Animalibus" (subsequently expressed by the aphorism "Omne Vivum ex Ovo"), that was announced in his *Exercitationes de Generatione Animalium* (London, 1651). No. 36.

Secondly the discovery of the Lymphatic System by Gaspard Aselli [c.1581–1626] and Olaus Rudbeck [1630–1702].

THESE discoveries were followed by the investigations of the intimate structures of Animals and Plants made by a group of eminent contemporary naturalists, with the aid of the then new instrument, the Microscope.

Robert Hooke [1635–1703], the versatile Curator of Experiments to the Royal Society, in 1665, published his *Micrographia*, a work in which the author intentionally touched upon many interesting subjects without working any of them out, content if he furnished the groundwork for others to build on. No. 40.

Among his observations were some of great import. Thus he first saw and named the "cells" in plants, for his subject being a dried cork he naturally judged them empty.

Hooke also studied the minute quartz crystals which he found in the cavity of a flint. Their mode of reflecting and refracting light, with the regularity of their figures, led him to suggest that crystals are built up of spheroids.

To Geology, also, Hooke was an important contributor. Supporting the organic origin of fossils, he explained in his *Lectures and Discourses of Earthquakes* (*Posthumous Works*, 1705), the processes of petrifaction, inclined towards the extinction of species in some cases and substituted a diluvial theory of his own to account for them, in lieu of the Noachian Deluge.

Jan Swammerdam [1637–1680], a noted Dutch physician and naturalist, specially devoted himself to the study of the anatomy of Insects. His *Historia Insectorum generalis* was published in 1669.

Nehemiah Grew [1628–1694], Secretary to the Royal Society, made a number of most careful researches into the Anatomy of Plants that were laid before the Royal Society in a series of papers between the years 1671 and 1677.

Among other things he correctly surmised the true nature

and functions of the stamens and pistils in flowers, modestly sharing part of the credit with Sir Thomas Millington. Grew, however, did not put his observation to proof. This discovery was announced to the Society in November 1676, but only printed and issued, with the second editions of some previous papers, in his *Anatomy of Plants*, in 1682. Incidentally, from a lecture published in the same volume, it is seen that Minerals were still divided into Earths, Stones, Ores, Metals, Sulphurs, and Salts.

No. 43.

Grew's first paper on the structure of Plants had only just been printed by the Royal Society in 1671, when that body received a communication on the same subject from MARCELLO MALPIGHI [1628–1694], an illustrious Italian physician and naturalist. Malpighi's memoir was then extended, and printed by the Society, in 1675, under the title of *Anatome Plantarum*. In it he gave the earliest account of the circulation of the sap and of the nutrition of plants.

Malpighi had already (1661) confirmed the existence of capillary circulation, that had been inferred by Harvey ; had given the first distinct idea of the organization of the lungs ; had demonstrated the structure of secreting glands ; and made several other important discoveries of a like nature, besides writing on the microscopical structure of Insects.

ANTHONY VAN LEEUWENHOEK [1632–1723], an eminent Dutch naturalist, with rough instruments of his own manufacture, made many interesting and important discoveries, such as the existence of the Wheel-animalcules (Rotifera) and their power of enduring desiccation, the mode of propagation of the Green-fly (Aphis), and of the development of many Insects : he also reaffirmed Malpighi's discovery of capillary circulation, displaying it in the tail of the tadpole. His observations were mostly communicated in letters to the Royal Society of London from 1673 onwards. These were collected and published in a series of volumes beginning in 1684.

Nos. 41 & 42.

MINERALOGY and Geology received further impetus about this period, mainly through the studies of the following naturalists :—

NICOLAUS STENO [1631–1686], a distinguished Danish

physician, subsequently Bishop of Titopolis, proposed an hypothesis as to the mode of growth of a Crystal from a primitive nucleus, that included the important discovery of the constancy of the angles of Crystals. He not only maintained the animal origin of the fossil shells, &c., but distinguished between marine and fluvatile formations, and argued in favour of the original horizontality of sedimentary deposits. His treatise, *De Solido intra Solidum naturaliter contento*, promulgating these views, appeared at Florence in 1669. No. 44.

Agostino Scilla [1639–1700], an Italian painter, also contended for the organic origin of fossils in 1670, illustrating his *Lettera risponsiva circa i Corpi Marini che Petrificati si trovano* by excellent plates, the original drawings for which, with the specimens, were acquired by Dr. John Woodward, and are now at Cambridge. No. 52.

Erasmus Bartholinus [1625–1698], a Danish geometrician, made known the double-refracting property of Calc-spar in his *Experimenta Crystalli Islandici disdiaclastici*, which appeared in 1670.

Christian Huygens [1629–1695] studied the laws of double refraction of Iceland Spar and explained them by means of an undulatory theory of light in his *Traité de la Lumière*, Leyden, 1690 : he sought to elucidate the peculiar cleavage of this mineral by building up crystals from spheroids, after the manner of Hooke.

THE earliest attempt at a systematic description of the natural history of the whole of Great Britain was by Joshua Childrey [1623–1670], antiquary, and Archdeacon of Sarum, who in 1661 published his *Britannia Baconica : or the Natural Rarities of England, Scotland, and Wales. According as they are to be found in every Shire.* This was mostly a compilation, and is interesting as showing the state of knowledge at the time, though its chief importance lies in the fact that it appears to have inspired Robert Plot [1640–1696], the first 'Custos' of the Ashmolean Museum, and professor of Chemistry at Oxford, with the idea of extending the scheme and treating each county elaborately. As a specimen he issued a *Natural History of Oxfordshire* in 1677 : this was followed by a *Natural* No. 53. No. 55.

History of Staffordshire in 1686, and he had projected histories of Middlesex and Kent. These were the forerunners of a numerous series of county natural histories by different authors.

Plot's volumes contained original observations and the first record of some English Plants.

Childrey's work may also have prompted the production of Sir Robert Sibbald's [1641–1722] similar work, *Scotia Illustrata*, that appeared in 1684.

SYSTEMATIC Zoology and Botany were next most considerably advanced by the labours of John Ray, or, as he wrote it before 1669, Wray [1627–1705], and his friend and co-worker Francis Willughby [1635–1672]. These two naturalists, dissatisfied with the status of Natural History, agreed to attempt a systematic description of the whole organic world, Willughby undertaking the Animals and Ray the Plants.

No. 46. Ray's *Catalogus Plantarum Angliæ, etc.*, London, 1670, was the first outcome of the travels the two friends had made in company : it enumerated only some 1,050 species, great care having been exercised to exclude varieties. In both this and the second edition, which appeared in 1677, the Plants were arranged in alphabetical order.

The early death of Willughby left the whole of the projected undertaking to Ray. He first edited and brought out

No. 50. Willughby's *Ornithologia* in 1676, an English translation following in 1678, and the *Historia Piscium* in 1686. Ray's

No. 48. first systematic work on Plants, the *Methodus Plantarum nova*, was produced in 1682, and revised in 1703 ; in this he foreshadowed the Natural System.

No. 49. Ray's greatest botanical work, the *Historia Plantarum*, the preparation of which had remained in abeyance so long as Robert Morison was engaged on a similar undertaking, was resumed on the latter's death, and came out in 1686–88 : it contained descriptions of some 6,900 plants. In 1690 his catalogue of British Plants re-arranged systematically was

No. 47. published under the title of *Synopsis Methodica Stirpium Britannicarum*, and gave accounts of some 250 more species than were cited in the *Catalogus*.

To Ray is due both the more accurate definition of

"species" and the employment of anatomical characters in the definition of the larger groups. Cuvier considered Ray's zoological work "yet more important" than his botanical, it being "the basis of all modern zoology." In geology he followed and improved upon Hooke, while he was one of the first to call attention to the denudation effected by rivers and the sea.

AMONG Ray's contemporaries the following deserve mention :—

Martin Lister [1638–1712], the English naturalist and correspondent of Ray, to whom he sent observations on Plants and on Spiders, of which he was one of the earliest students. His *Historia Animalium Angliæ*, 1678, contains accounts of the Spiders and of the Mollusca, including the fossil shells, which he considered, as Ray did, to be remains of real organisms. From Lister apparently emanated the first suggestion as to the formation of Geological Maps. No. 51.

Robert Morison [1620–1683], Botanist to Charles II., and afterwards Professor of Botany at Oxford, wrote Pts. ii. and iii. of a *Plantarum Historiæ universalis Oxoniensis*, which appeared in 1680 and 1699, under the editorship of J. Bobart : the first part of the work was never issued. Morison elaborated a system of classification which was apparently largely borrowed from Cæsalpinus.

August Q. Rivinus [1652–1723], with whom Ray had some controversy, was also a systematist of note, whose *Introductio generalis in Rem Herbarium* was published, at Leipsic, in 1690, and followed by memoirs on the different orders which he constituted. He suggested that two names should be given to each plant.

Joseph Pitton de Tournefort [1656–1708], a celebrated French botanist, was the practical founder of genera, and therefore in great measure of the present system of classification. His *Élemens de Botanique* came out in 1694 : it was afterwards issued in Latin as *Institutiones Rei Herbariæ*. His system of classification was long in vogue on the Continent.

Rudolphus Jacobus Camerarius [1665–1721], the most celebrated of a family of Tübingen physicians, and a botanist of

note, furnished the final proof of the sexuality of Plants. His conclusions, based on a long series of careful experiments, were published in the form of a letter to M. B. Valentine, entitled *De sexu Plantarum epistola*, Tübingen, 1694.

ABOUT this period the natural history of the Cape of Good Hope came to be studied, and primarily by WILLEM TEN RHIJNE [c.1600–], physician to the Dutch East India Company, who sent to J. BREYNIUS [1637–1697] some rare plants, of which the latter published a list and description as an appendix to the first century of his *Exotic Plants* in 1678. Rhijne afterwards issued a *Schediasma de Promontorio Bonæ Spei* in 1686.

The Dutch East Indies were investigated by :—

GEORG EBERHARD RUMPF [c.1627–c.1706], Consul at Amboina, who made extensive researches and observations.
No. 56. His *D'Amboinsche Rariteitkamer*, published at Amsterdam, 1705, was a distinct advance over previous works on the East Indies : his more important *Herbarium Amboinense*, in 6 parts, edited by Burman, did not appear till 1741–55 ;

FRANÇOIS LEGUAT [1637–1735], the French traveller, who amongst other things in his *Voyages et avantures . . . en deux*
No. 60. *Isles desertes des Indes orientales*, London, 1708, gives the earliest figure and description of that flightless bird the Solitaire *(Pezophaps solitarius)*.

AMONG collectors of note of the period, two call for special mention :—

JAMES PETIVER [c.1657–1718], apothecary, was an industrious collector, who formed a miscellaneous museum. He was the first discoverer of many English Plants, and assisted
No. 58. Ray. He also published (1693–1717) descriptions, with illustrations, of specimens in his own collections, or figured in contemporary works. On his death his books and specimens were purchased by Sir Hans Sloane : among them was the copy
No. 56. of Rumpf's *D'Amboinsche Rariteitkamer*, from which Petiver traced the plates for his own *Gazophyllacium*.

SIR HANS SLOANE, Bart. [1660–1753], best known as a great collector, and the patron of science, was also author of a

catalogue of Jamaica Plants, issued in 1696, and of *A Voyage to . . . Madera, Barbadoes . . . and Jamaica, with the natural history of the last*, 1707, 25. No. 61.

The acquisition of his collections by the nation in 1753, and the founding, with them as a basis, of the British Museum, were events that, after a time, exercised no small influence on the development of Natural Science.

GEOLOGY did not make any considerable progress at this time, but JOHN WOODWARD [1665–1728], the geologist and founder of the Museum at Cambridge bearing his name, published in 1695 *An Essay toward a Natural History of the Earth*, from which it is apparent that he recognized the existence of various strata of the Earth's crust, but failed to understand the true disposition of the fossils in them, considering that the whole world had been dissolved at the flood, and that the fossils subsequently settled down in the order of their gravity, the heaviest sinking first. Woodward's *Thoughts and Experiments concerning Vegetation*, read before the Royal Society in 1699 (*Phil. Trans. vol. xxi.*) embody some of the earliest evidences produced of Transpiration in Plants. No. 59.

ANTONIO VALLISNERI [1661–1730], an Italian naturalist, whose works were rich in original observations, ridiculed the theories of Woodward and others in his *Dei Corpi Marini* (Venice, 1721), described the fossils of Monte Bolca, and attempted the first general sketch of the marine deposits of Italy.

THE placing of Cryptogamic Botany on a proper footing at this date was mainly the work of JOHANN JACOB DILLENIUS [1687–1747], the first Professor of Botany at the University of Oxford, and of his contemporary and rival, the Italian botanist, PIETRO ANTONIO MICHIELI (or MICHELI) [1679–1737]. Both these naturalists, however, erred in their interpretation of the parts of fructification, and the true explanation of these organs was only arrived at many years later by JOHANN HEDWIG [1730–1799].

Dillenius' chief work, the *Historia Muscorum*, appeared at Oxford in 1741, and his original drawings for some of the

plates are preserved in the Botanical Department of this Museum. It was the first work printed in England in which any of the Linnean specific characters were exhibited, and was implicitly trusted to by Linnæus, who adopted the species.

AMONG other Naturalists of note living prior to the Natural History Reformation effected by Linnæus, were :—

René A. Ferchault de Réaumur [1683–1757], the celebrated French natural philosopher and entomologist, whose *Mémoires pour servir à l'Histoire des Insectes*, in 6 vols., Paris, 1734-42, were long the standard work on Entomology.

Albert Seba [1665–1736], the Dutch naturalist, who formed large collections of great worth, of which a remarkable illustrated catalogue, entitled, *Locupletissimi Rerum Naturalium Thesauri accurata descriptio*, was published at Amsterdam in 1734–65.

Petrus Artedi [1705–1735], a young Swedish naturalist and friend of Linnæus, had begun an important work on Fishes, which Linnæus edited and brought out. Artedi's *Ichthyologia*, Lugduni Batavorum, 1738, made some advance towards a natural arrangement; his genera were well constituted and he laid down rules for the nomenclature of genera and species as well as created a precise terminology for all the interior and exterior parts of animals.

Georges Louis Leclerc, Comte de Buffon [1707–1788], the celebrated French naturalist, who was born the same year as Linnæus, produced a work of descriptive Natural History which was without equal in its time and, by the addition in later editions of the Linnean nomenclature, became a most valuable work and the basis of succeeding works of a like nature for very many years.

Johan Gottskalk Wallerius [1709–1785], a Swedish chemist, who was the first to apply chemistry to agriculture, gave in his *Mineralogia*, Stockholm, 1747, a more complete description of Minerals according to their external characters and a better classification than any before published, basing it on a critical comparison of those that preceded.

Axel Fredric Cronstedt [1722–1765], a Swedish chemist and mineralogist, first made use of the blow-pipe in the deter-

mination of Minerals. He also laid the foundations, in his *Försök till Mineralogie*, Stockholm, 1758, of the modern system of Mineralogy ; he classified the "Stones," which included the "Earths," according to their composition as calcareous, siliceous, argillaceous and so forth.

IT will be seen, therefore, that by the time of Linnæus the outlines of the several Natural Sciences, as now recognised, had begun to be manifest, and the one thing wanting to enable further and more substantial progress to be made was the introduction of method into their study. This Linnæus was successful in supplying. Arrangement with him amounted to a passion, and he delighted in devising classifications. He enunciated the true principles for defining genera and species, and this, with his adoption of the simple binomial method of nomenclature, enabled the daily increasing number of new Plants and Animals to be sorted, and provisionally placed, till their true affinities were ascertained.

His necessarily arbitrary classifications have given way to more natural arrangements in all the three kingdoms, but the underlying method has remained and enabled continuous progress to be made down to the present time.

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